FIG. 1

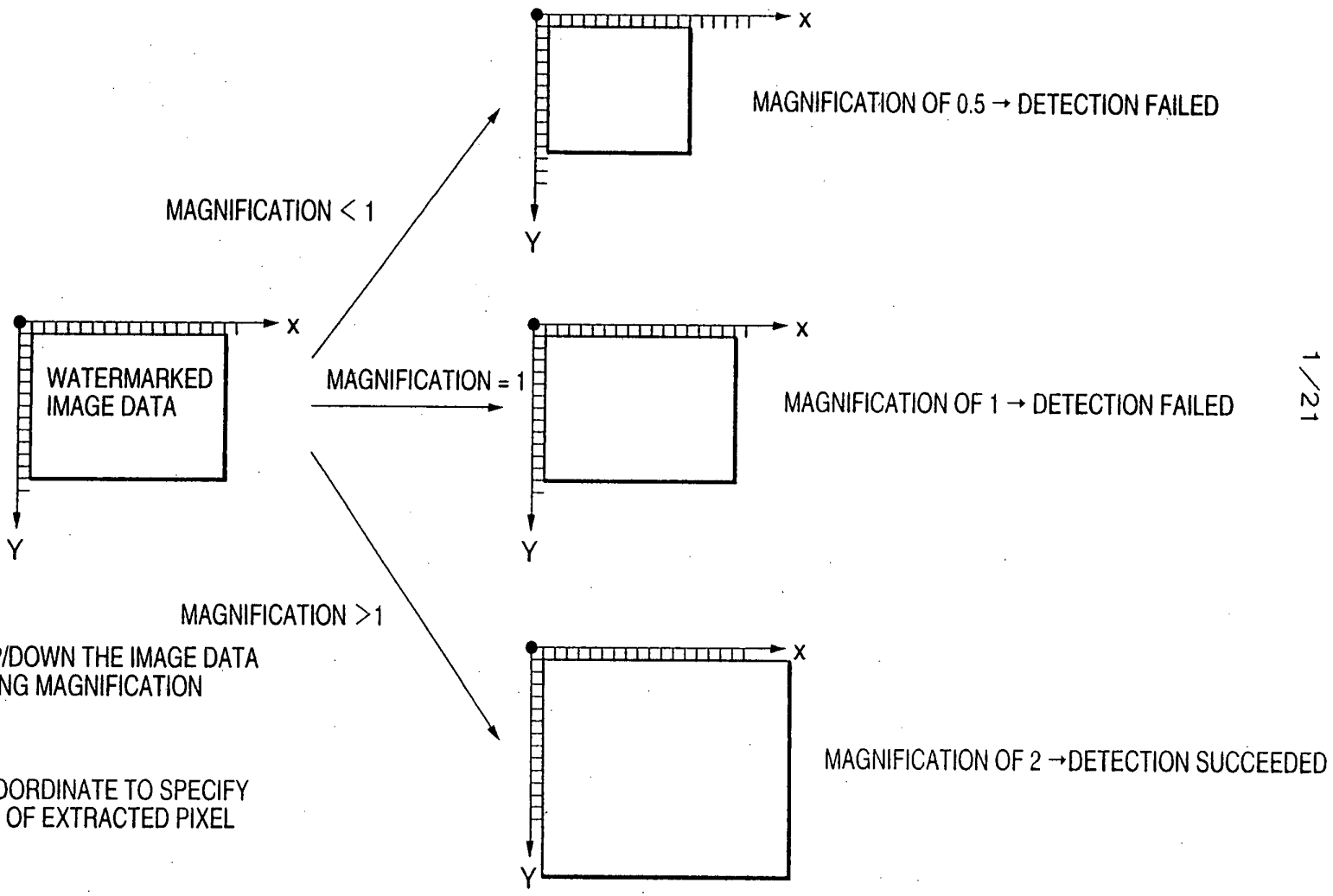

WATERMARKED IMAGE DATA
X
Y
MAGNIFICATION < 1
MAGNIFICATION = 1
MAGNIFICATION >1
MAGNIFICATION OF 0.5 → DETECTION FAILED
MAGNIFICATION OF 1 → DETECTION FAILED
MAGNIFICATION OF 2 →DETECTION SUCCEEDED
· SCALE UP/DOWN THE IMAGE DATA BY VARYING MAGNIFICATION
· FIX X-Y COORDINATE TO SPECIFY POSITION OF EXTRACTED PIXEL

FIG. 2

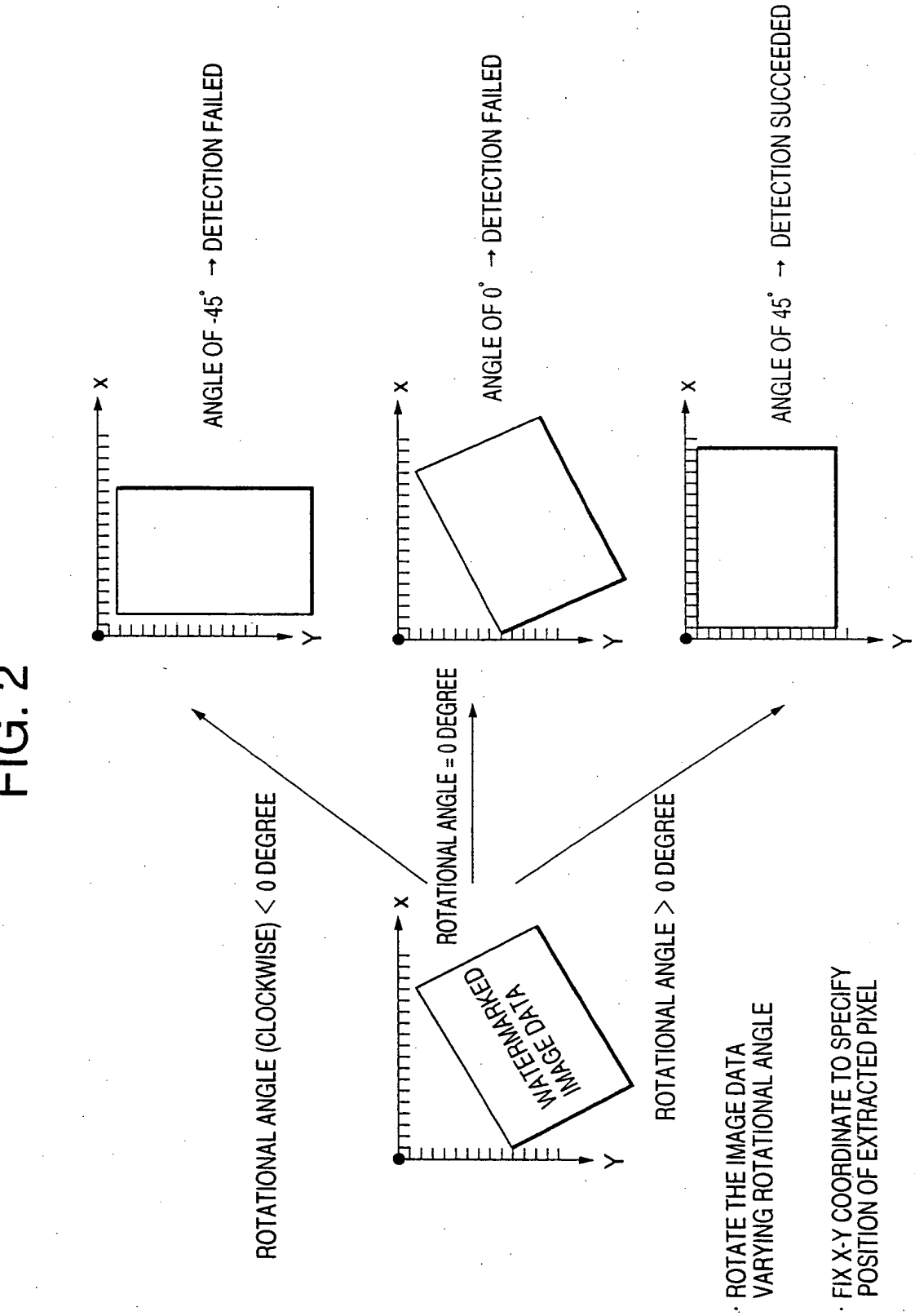

ANGLE OF -45° → DETECTION FAILED
ANGLE OF 0° → DETECTION FAILED
ANGLE OF 45° → DETECTION SUCCEEDED
X
Y
ROTATIONAL ANGLE (CLOCKWISE) < 0 DEGREE
ROTATIONAL ANGLE = 0 DEGREE
ROTATIONAL ANGLE > 0 DEGREE
WATERMARKED IMAGE DATA
· ROTATE THE IMAGE DATA VARYING ROTATIONAL ANGLE
· FIX X-Y COORDINATE TO SPECIFY POSITION OF EXTRACTED PIXEL

FIG. 3

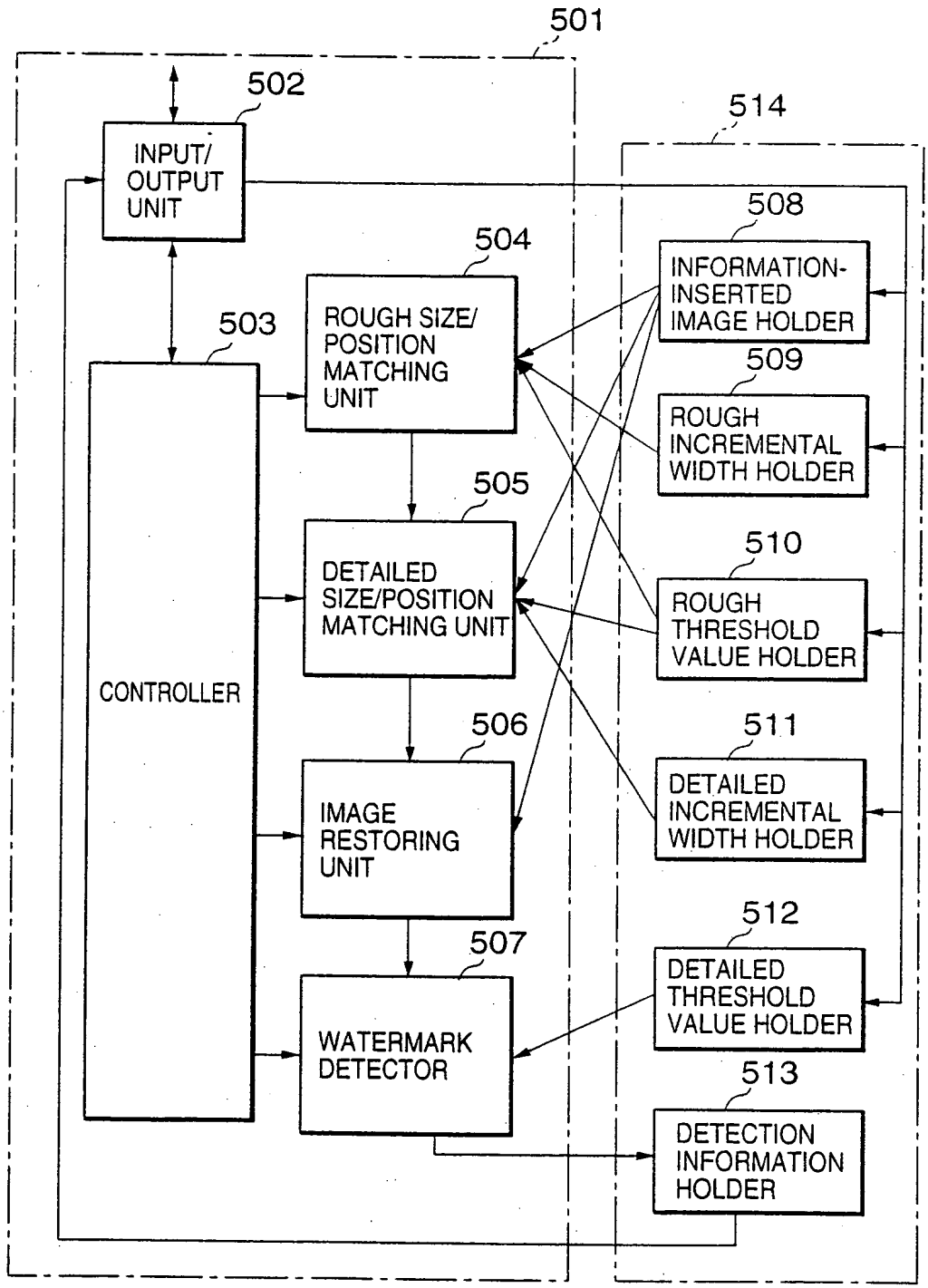

501
502
INPUT/
OUTPUT
UNIT
514
508
INFORMATION-
INSERTED
IMAGE HOLDER
504
ROUGH SIZE/
POSITION
MATCHING
UNIT
503
509
ROUGH
INCREMENTAL
WIDTH HOLDER
505
DETAILED
SIZE/POSITION
MATCHING UNIT
510
ROUGH
THRESHOLD
VALUE HOLDER
CONTROLLER
506
511
DETAILED
INCREMENTAL
WIDTH HOLDER
IMAGE
RESTORING
UNIT
512
507
DETAILED
THRESHOLD
VALUE HOLDER
WATERMARK
DETECTOR
513
DETECTION
INFORMATION
HOLDER

FIG. 4

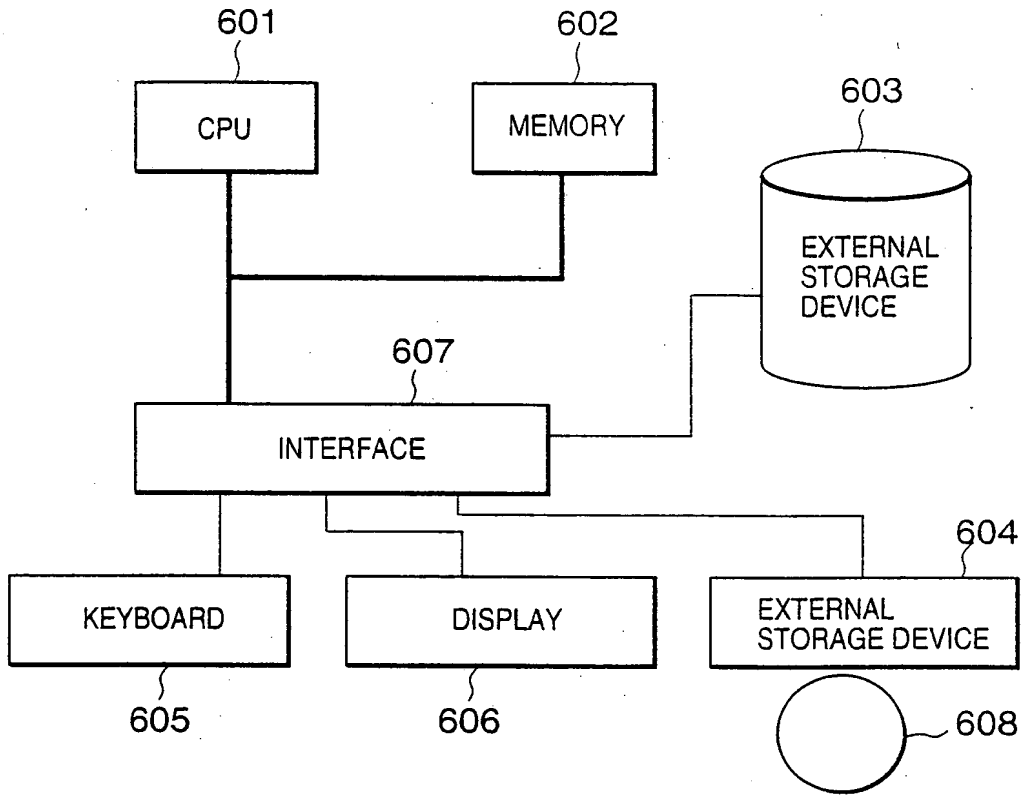

601
602
603
CPU
MEMORY
EXTERNAL STORAGE DEVICE
607
INTERFACE
604
KEYBOARD
DISPLAY
EXTERNAL STORAGE DEVICE
605
606
608

FIG. 5

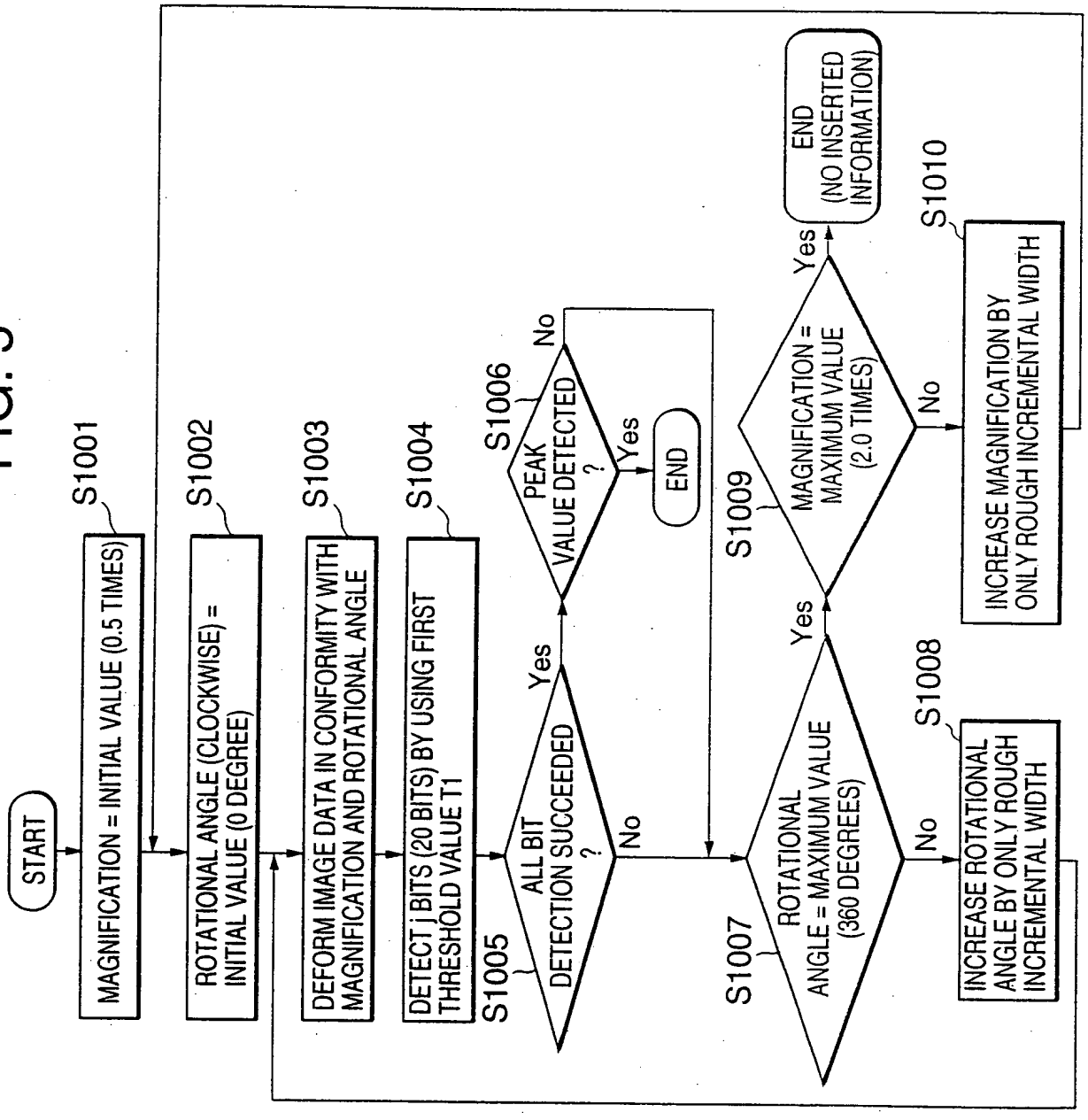

START
S1001
MAGNIFICATION = INITIAL VALUE (0.5 TIMES)
S1002
ROTATIONAL ANGLE (CLOCKWISE) = INITIAL VALUE (0 DEGREE)
S1003
DEFORM IMAGE DATA IN CONFORMITY WITH MAGNIFICATION AND ROTATIONAL ANGLE
S1004
DETECT j BITS (20 BITS) BY USING FIRST THRESHOLD VALUE T1
S1005
ALL BIT DETECTION SUCCEEDED ?
Yes
No
S1006
PEAK VALUE DETECTED ?
No
Yes
END
S1007
ROTATIONAL ANGLE = MAXIMUM VALUE (360 DEGREES)
Yes
No
S1008
INCREASE ROTATIONAL ANGLE BY ONLY ROUGH INCREMENTAL WIDTH
S1009
MAGNIFICATION = MAXIMUM VALUE (2.0 TIMES)
Yes
No
END (NO INSERTED INFORMATION)
S1010
INCREASE MAGNIFICATION BY ONLY ROUGH INCREMENTAL WIDTH

FIG. 6

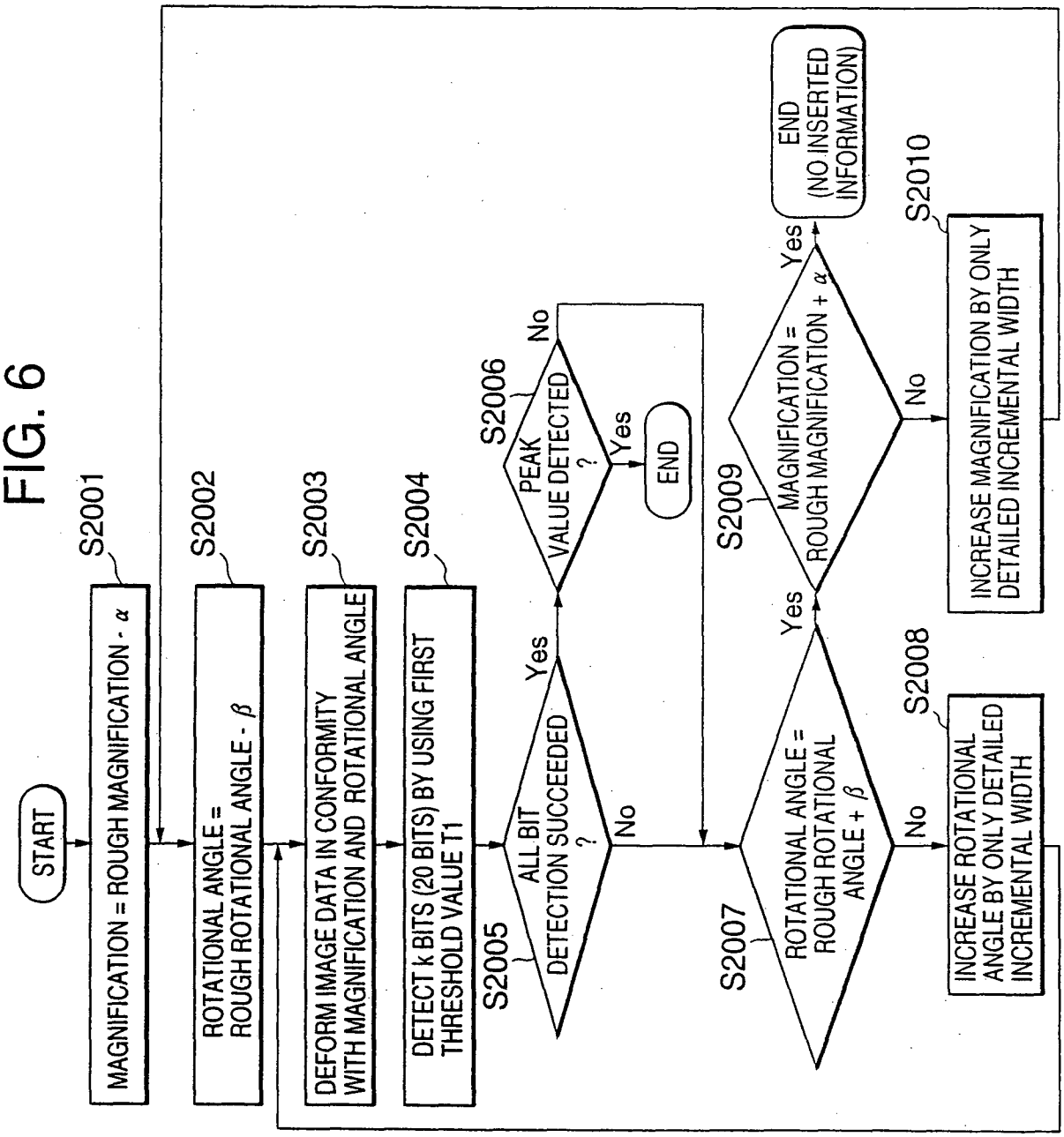

START
S2001
MAGNIFICATION = ROUGH MAGNIFICATION - α
S2002
ROTATIONAL ANGLE = ROUGH ROTATIONAL ANGLE - β
S2003
DEFORM IMAGE DATA IN CONFORMITY WITH MAGNIFICATION AND ROTATIONAL ANGLE
S2004
DETECT k BITS (20 BITS) BY USING FIRST THRESHOLD VALUE T1
S2005
ALL BIT DETECTION SUCCEEDED ?
Yes
No
S2006
PEAK VALUE DETECTED ?
No
Yes
END
S2007
ROTATIONAL ANGLE = ROUGH ROTATIONAL ANGLE + β
Yes
No
S2008
INCREASE ROTATIONAL ANGLE BY ONLY DETAILED INCREMENTAL WIDTH
S2009
MAGNIFICATION = ROUGH MAGNIFICATION + α
Yes
No
END (NO INSERTED INFORMATION)
S2010
INCREASE MAGNIFICATION BY ONLY DETAILED INCREMENTAL WIDTH

FIG. 7

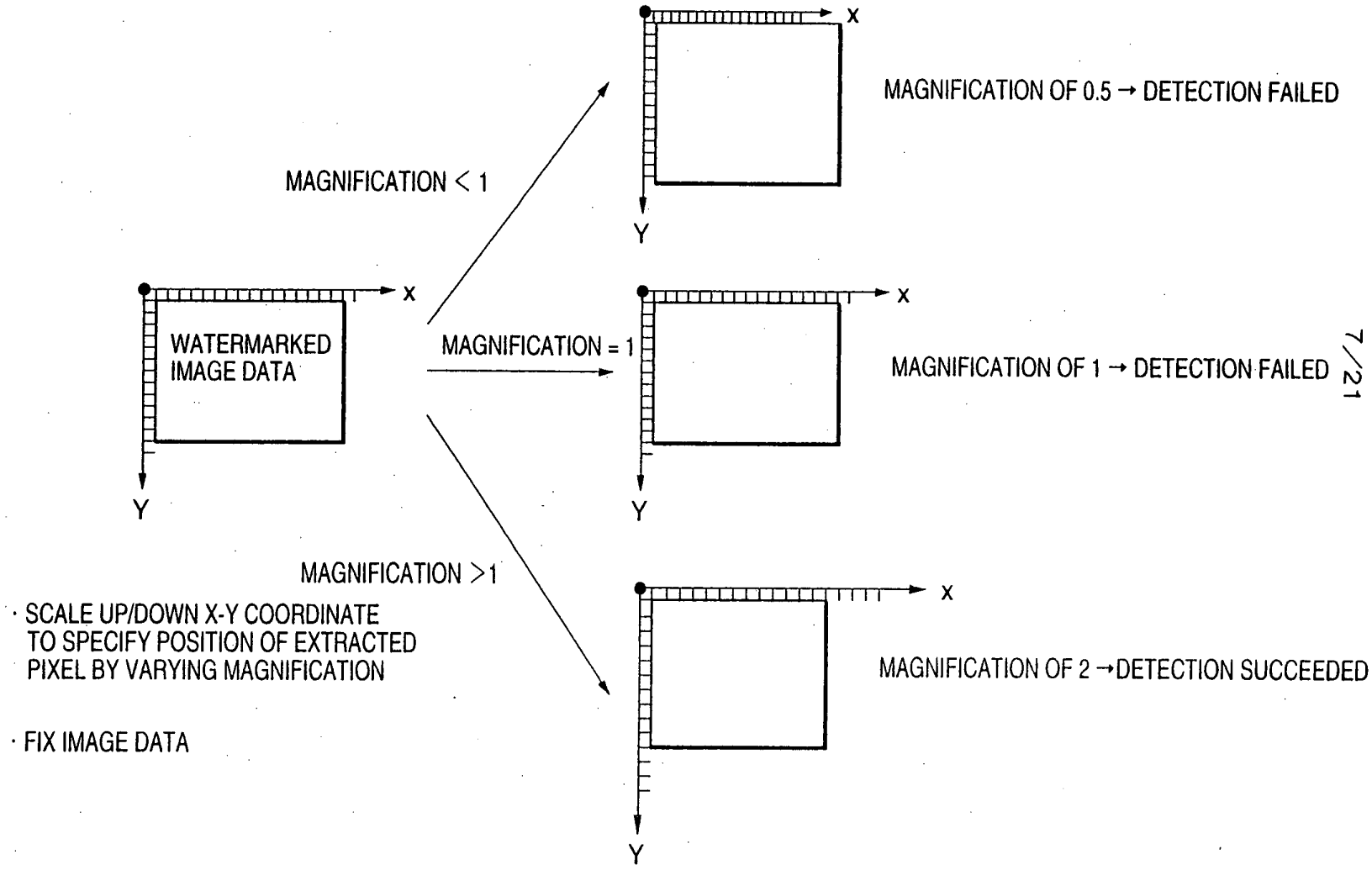

WATERMARKED IMAGE DATA
X
Y
MAGNIFICATION < 1
MAGNIFICATION = 1
MAGNIFICATION >1
MAGNIFICATION OF 0.5 → DETECTION FAILED
MAGNIFICATION OF 1 → DETECTION FAILED
MAGNIFICATION OF 2 →DETECTION SUCCEEDED
· SCALE UP/DOWN X-Y COORDINATE TO SPECIFY POSITION OF EXTRACTED PIXEL BY VARYING MAGNIFICATION
· FIX IMAGE DATA

FIG. 8

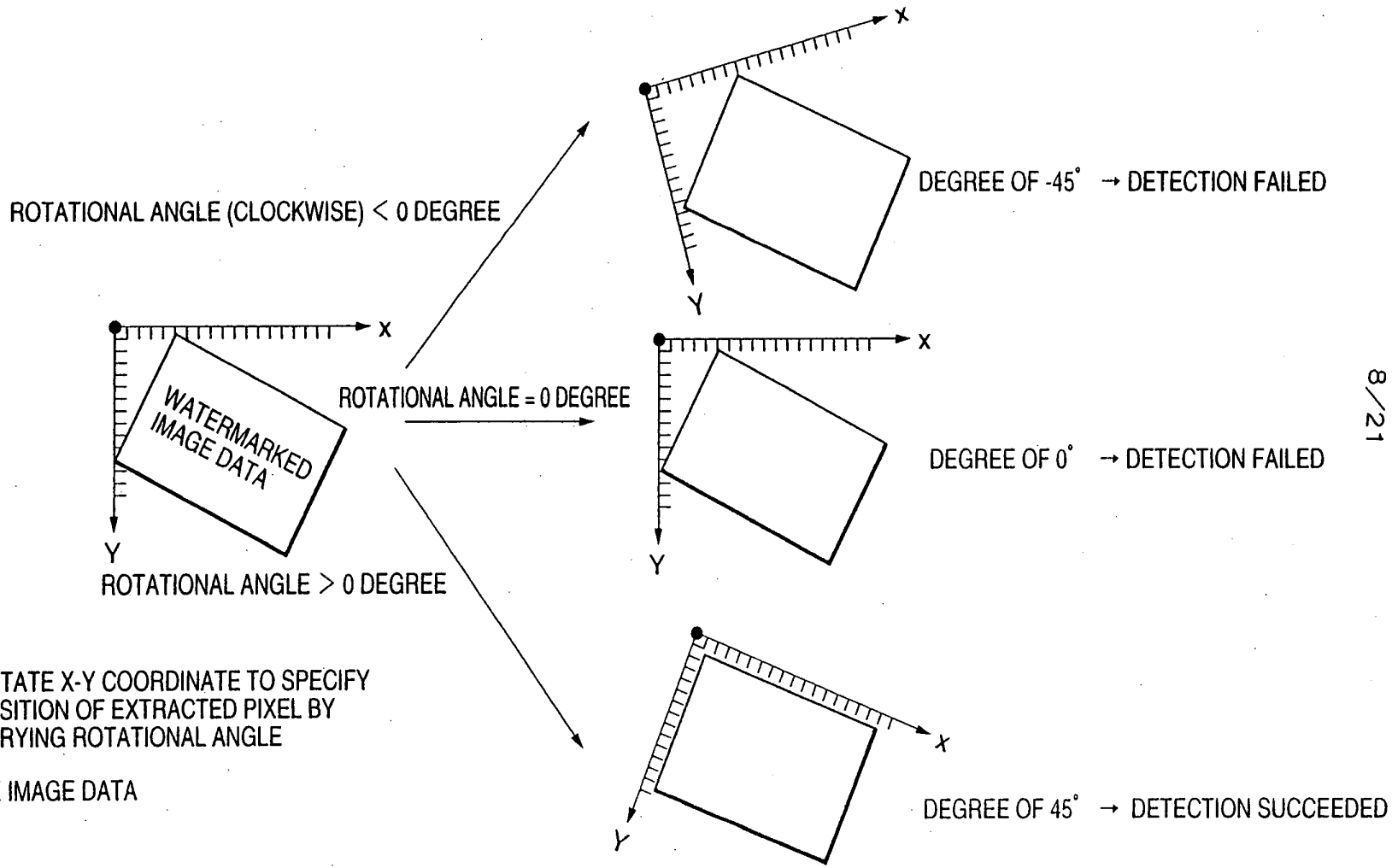

ROTATIONAL ANGLE (CLOCKWISE) < 0 DEGREE
DEGREE OF -45° → DETECTION FAILED
X
Y
WATERMARKED IMAGE DATA
ROTATIONAL ANGLE = 0 DEGREE
DEGREE OF 0° → DETECTION FAILED
ROTATIONAL ANGLE > 0 DEGREE
· ROTATE X-Y COORDINATE TO SPECIFY POSITION OF EXTRACTED PIXEL BY VARYING ROTATIONAL ANGLE
· FIX IMAGE DATA
DEGREE OF 45° → DETECTION SUCCEEDED

FIG. 9

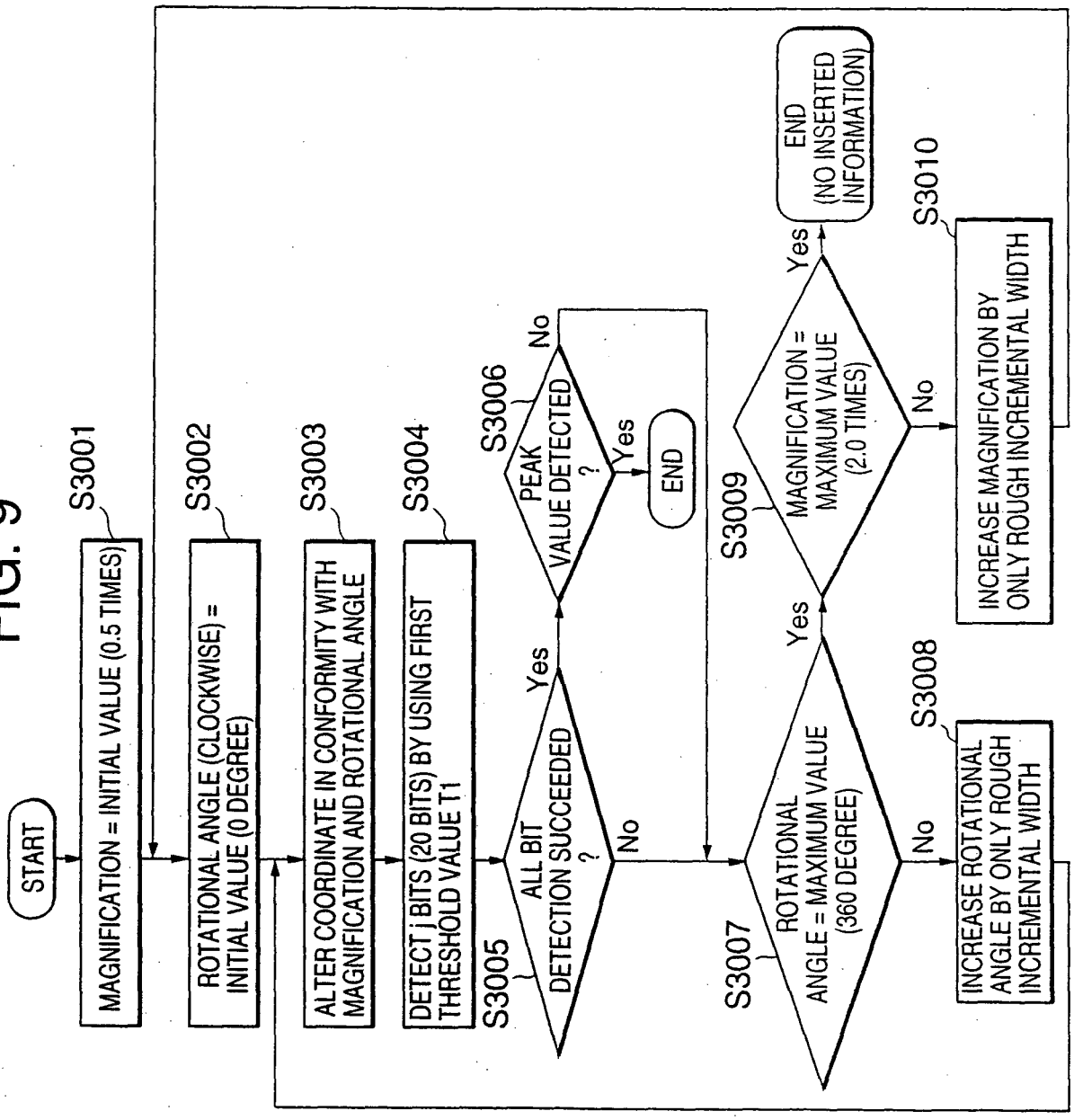

START
S3001
MAGNIFICATION = INITIAL VALUE (0.5 TIMES)
S3002
ROTATIONAL ANGLE (CLOCKWISE) = INITIAL VALUE (0 DEGREE)
S3003
ALTER COORDINATE IN CONFORMITY WITH MAGNIFICATION AND ROTATIONAL ANGLE
S3004
DETECT j BITS (20 BITS) BY USING FIRST THRESHOLD VALUE T1
S3005
ALL BIT DETECTION SUCCEEDED ?
Yes
No
S3006
PEAK VALUE DETECTED ?
No
Yes
END
S3007
ROTATIONAL ANGLE = MAXIMUM VALUE (360 DEGREE)
Yes
No
S3008
INCREASE ROTATIONAL ANGLE BY ONLY ROUGH INCREMENTAL WIDTH
S3009
MAGNIFICATION = MAXIMUM VALUE (2.0 TIMES)
Yes
No
S3010
INCREASE MAGNIFICATION BY ONLY ROUGH INCREMENTAL WIDTH
END (NO INSERTED INFORMATION)

FIG. 10

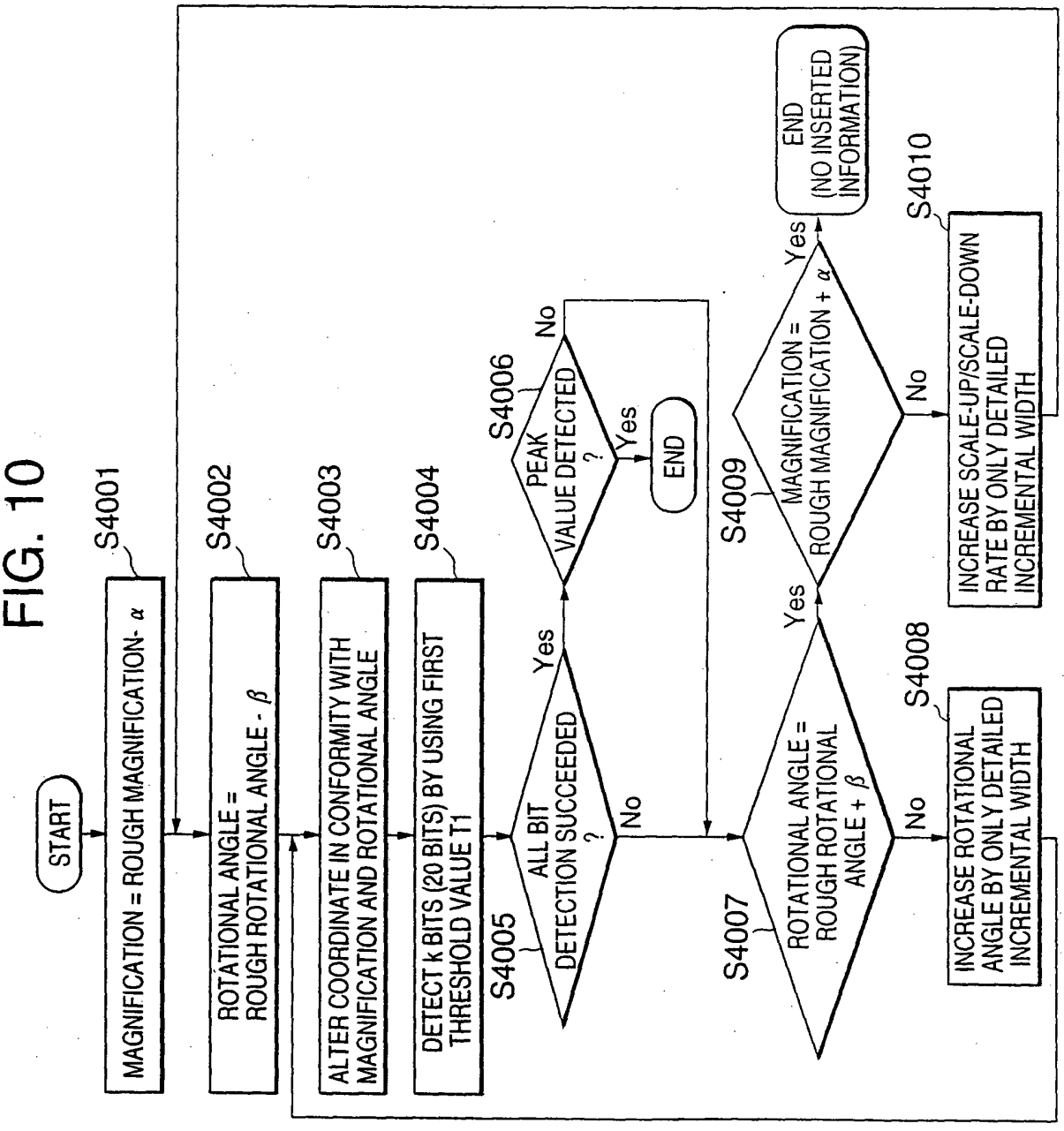

START
S4001
MAGNIFICATION = ROUGH MAGNIFICATION- α
S4002
ROTATIONAL ANGLE = ROUGH ROTATIONAL ANGLE - β
S4003
ALTER COORDINATE IN CONFORMITY WITH MAGNIFICATION AND ROTATIONAL ANGLE
S4004
DETECT k BITS (20 BITS) BY USING FIRST THRESHOLD VALUE T1
S4005
ALL BIT DETECTION SUCCEEDED ?
Yes
No
S4006
PEAK VALUE DETECTED ?
No
Yes
END
S4007
ROTATIONAL ANGLE = ROUGH ROTATIONAL ANGLE + β
Yes
No
S4008
INCREASE ROTATIONAL ANGLE BY ONLY DETAILED INCREMENTAL WIDTH
S4009
MAGNIFICATION = ROUGH MAGNIFICATION + α
Yes
No
END (NO INSERTED INFORMATION)
S4010
INCREASE SCALE-UP/SCALE-DOWN RATE BY ONLY DETAILED INCREMENTAL WIDTH

FIG. 11

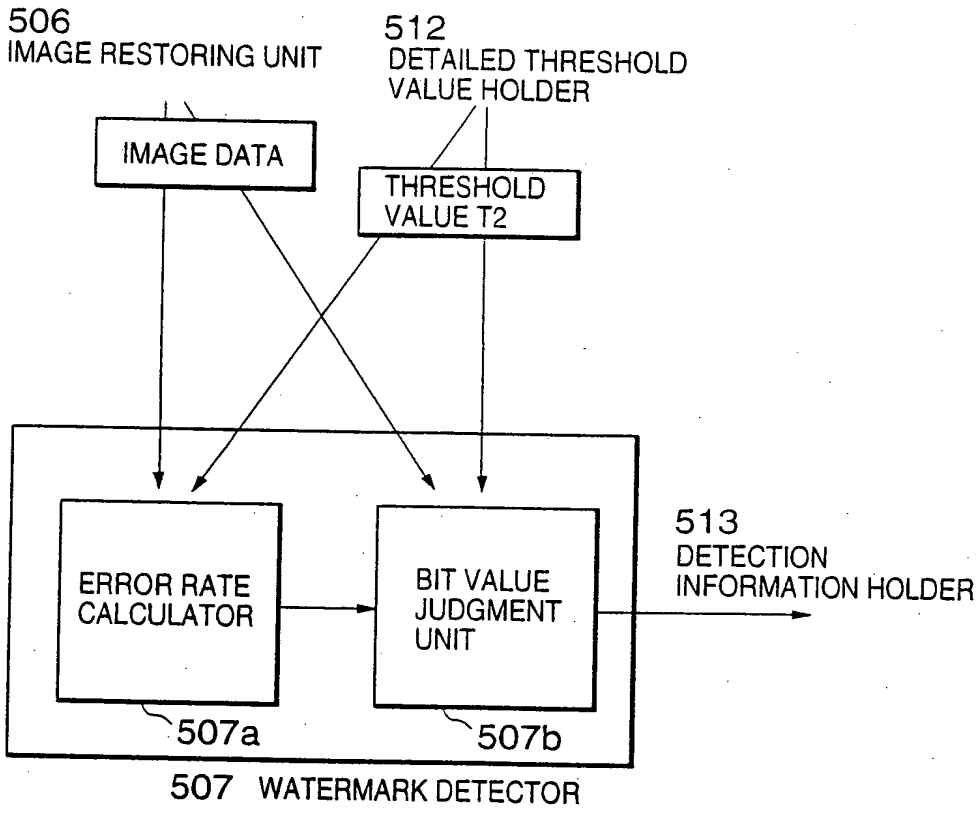

506
IMAGE RESTORING UNIT
512
DETAILED THRESHOLD VALUE HOLDER
IMAGE DATA
THRESHOLD VALUE T2
ERROR RATE CALCULATOR
BIT VALUE JUDGMENT UNIT
513
DETECTION INFORMATION HOLDER
507a
507b
507 WATERMARK DETECTOR

FIG. 12A

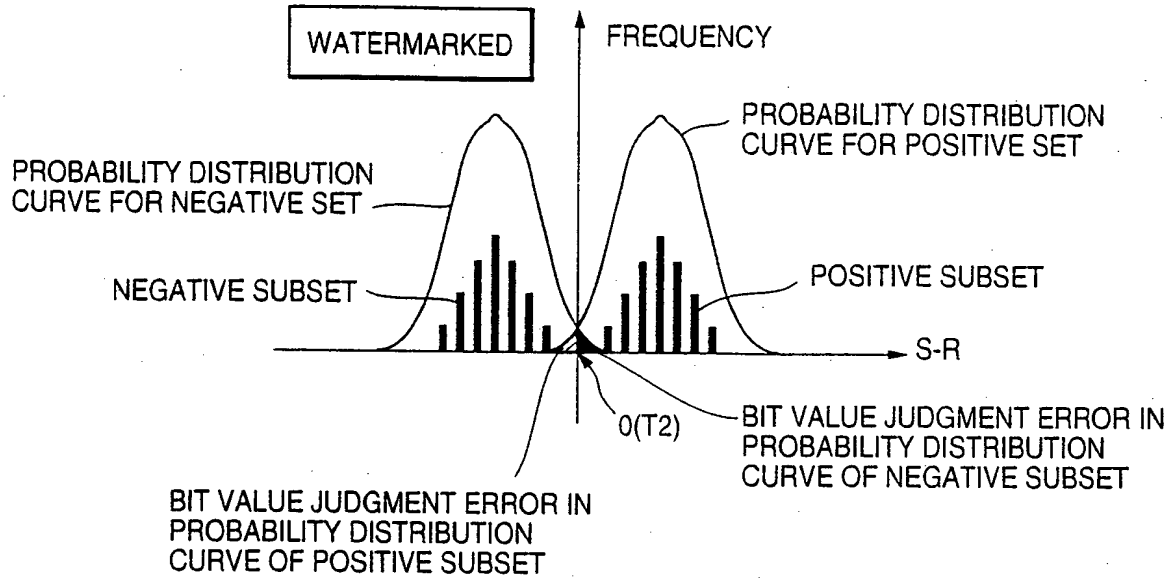


FIG. 12B

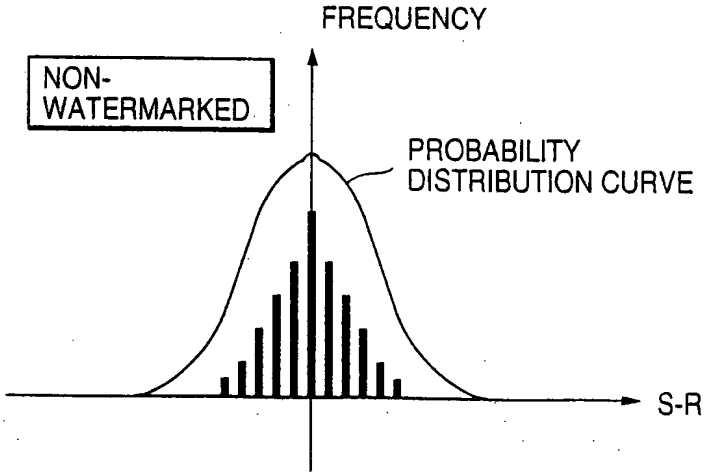


FIG. 13

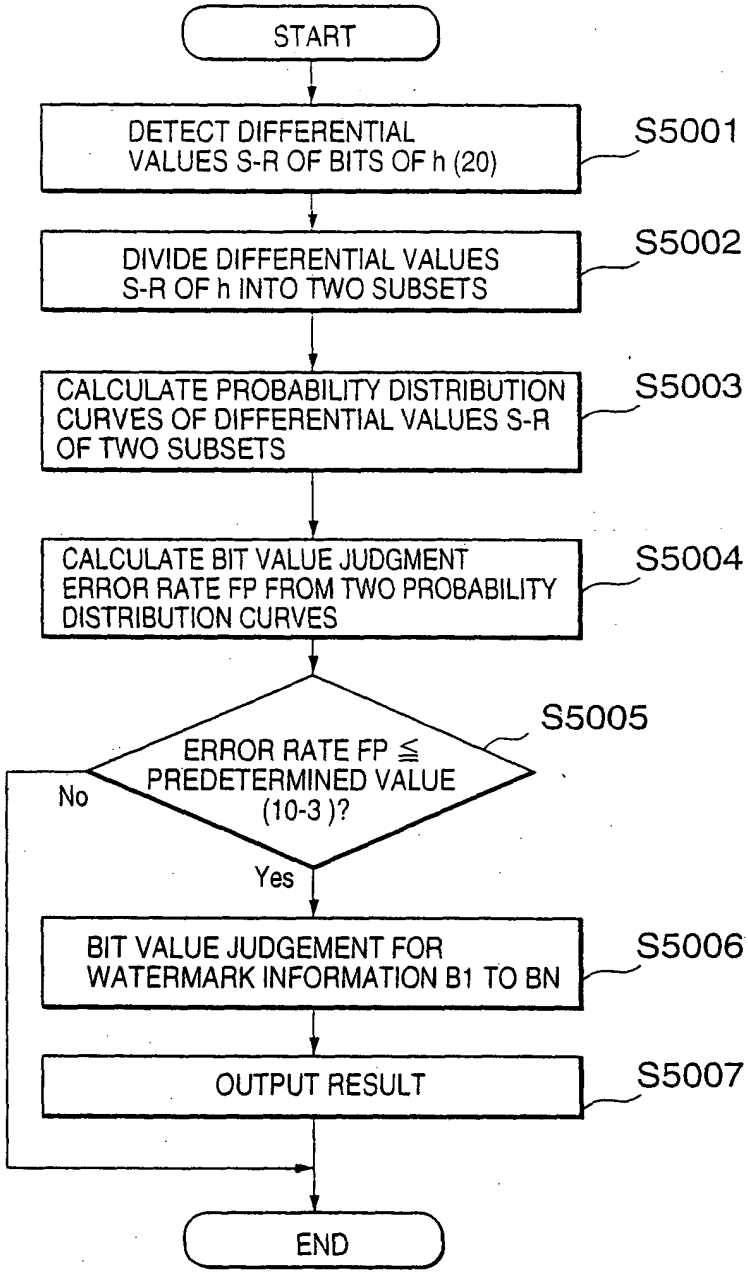

START
DETECT DIFFERENTIAL VALUES S-R OF BITS OF h (20)
S5001
DIVIDE DIFFERENTIAL VALUES S-R OF h INTO TWO SUBSETS
S5002
CALCULATE PROBABILITY DISTRIBUTION CURVES OF DIFFERENTIAL VALUES S-R OF TWO SUBSETS
S5003
CALCULATE BIT VALUE JUDGMENT ERROR RATE FP FROM TWO PROBABILITY DISTRIBUTION CURVES
S5004
ERROR RATE FP ≦ PREDETERMINED VALUE (10-3)?
S5005
No
Yes
BIT VALUE JUDGEMENT FOR WATERMARK INFORMATION B1 TO BN
S5006
OUTPUT RESULT
S5007
END

FIG. 14

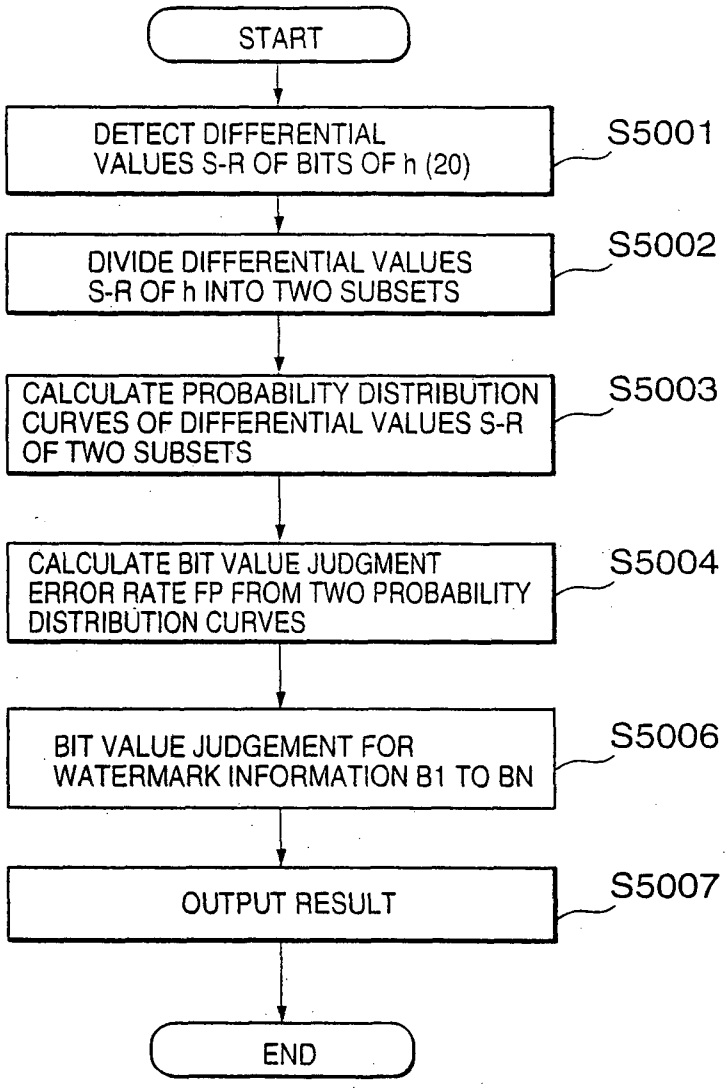

START
DETECT DIFFERENTIAL VALUES S-R OF BITS OF h (20)
S5001
DIVIDE DIFFERENTIAL VALUES S-R OF h INTO TWO SUBSETS
S5002
CALCULATE PROBABILITY DISTRIBUTION CURVES OF DIFFERENTIAL VALUES S-R OF TWO SUBSETS
S5003
CALCULATE BIT VALUE JUDGMENT ERROR RATE FP FROM TWO PROBABILITY DISTRIBUTION CURVES
S5004
BIT VALUE JUDGEMENT FOR WATERMARK INFORMATION B1 TO BN
S5006
OUTPUT RESULT
S5007
END

FIG. 15

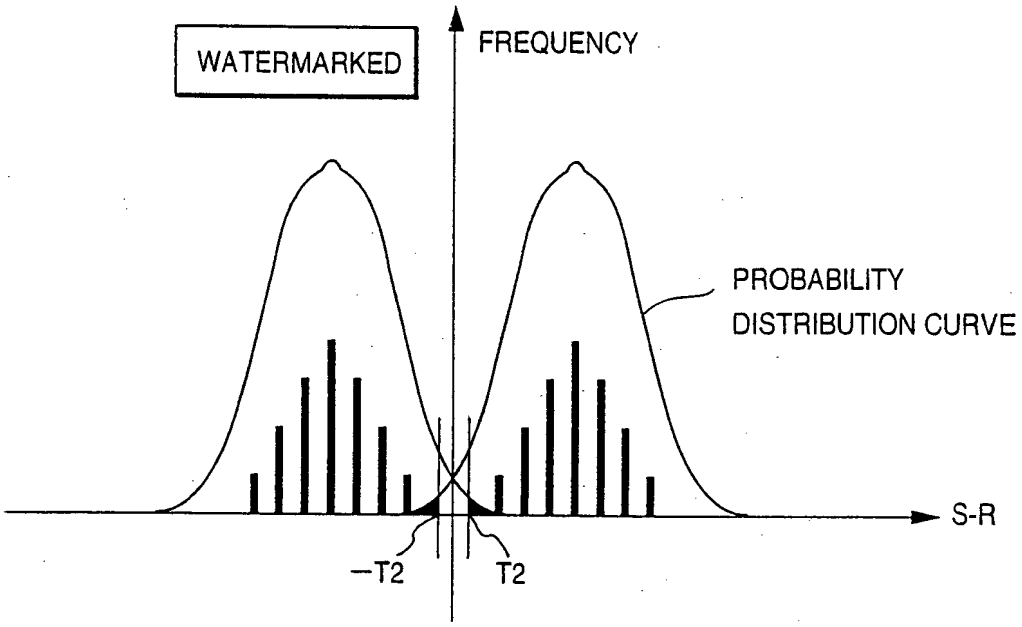

WATERMARKED
FREQUENCY
PROBABILITY
DISTRIBUTION CURVE
S-R
−T2
T2

FIG. 16

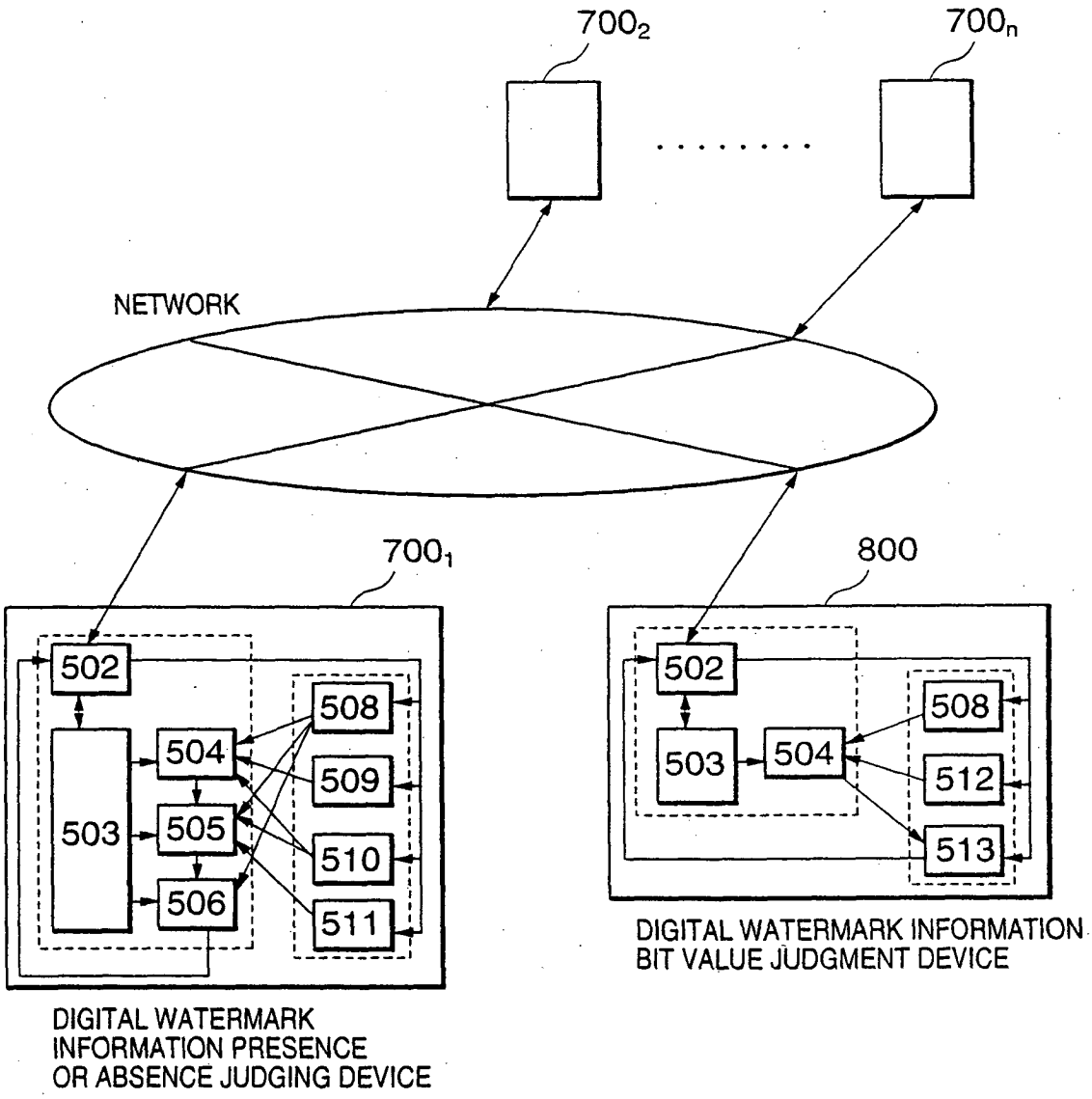

700_2
700_n
NETWORK
700_1
800
502
503
504
505
506
508
509
510
511
502
503
504
508
512
513
DIGITAL WATERMARK INFORMATION PRESENCE OR ABSENCE JUDGING DEVICE
DIGITAL WATERMARK INFORMATION BIT VALUE JUDGMENT DEVICE

FIG. 17

SHIFT TO Web SERVER 900_1 TO BUILD UP WATERMARK PRESENCE OR ABSENCE JUDGMENT DEVICE 700_1, AND WHEN THERE IS WATERMARK, BIT VALUE JUDGMENT IS REQUESTED TO BIT VALUE JUDGMENT DEVICE 800. AFTER PROCESSING IS FINISHED, SHIFT TO NEXT Web SERVER.

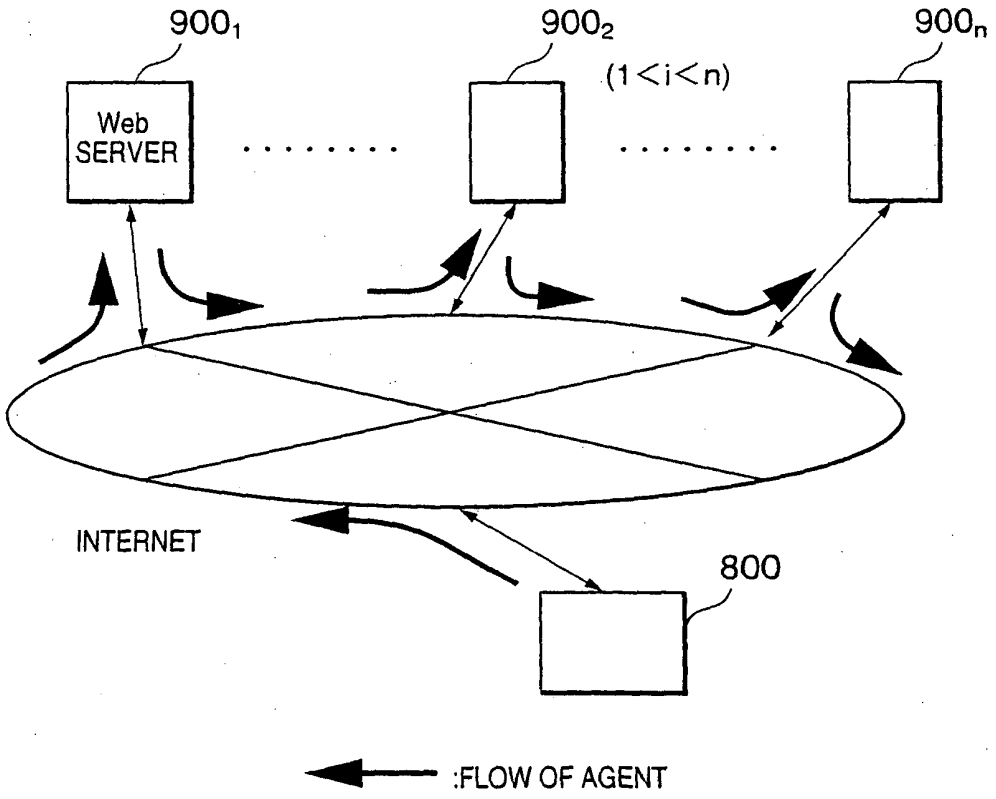


FIG. 18

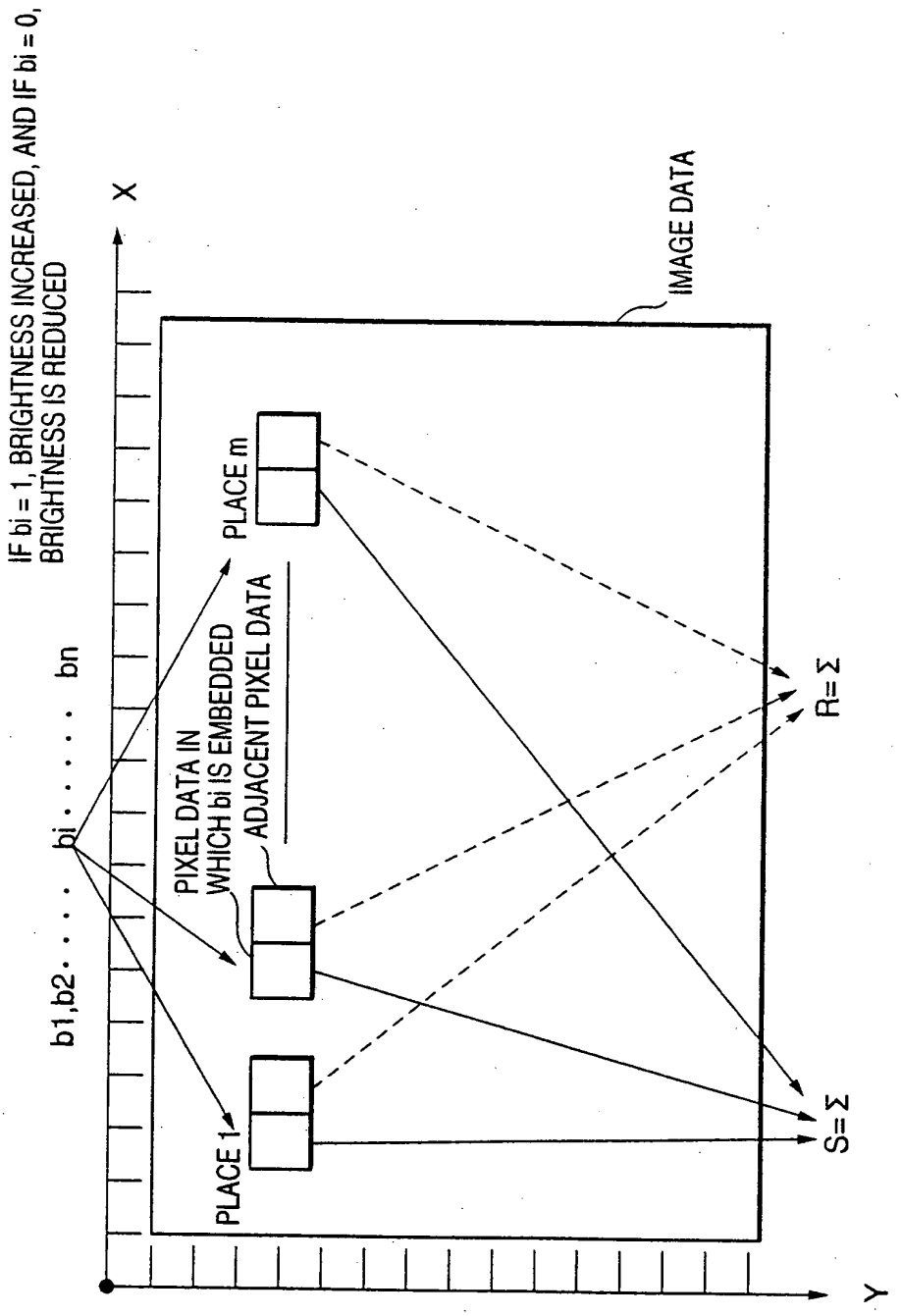

IF bi = 1, BRIGHTNESS INCREASED, AND IF bi = 0, BRIGHTNESS IS REDUCED
b1,b2 . . . . bi . . . . . bn
X
Y
IMAGE DATA
PLACE m
PLACE 1
PIXEL DATA IN WHICH bi IS EMBEDDED
ADJACENT PIXEL DATA
R= Σ
S= Σ
JUDGMENT:S−R>T →bi=1 (T REPRESENTS POSITIVE THRESHOLD VALUE)
S−R<−T →bi=0
−T< S−R<T →NO WATERMARK EMBEDDED

FIG. 19

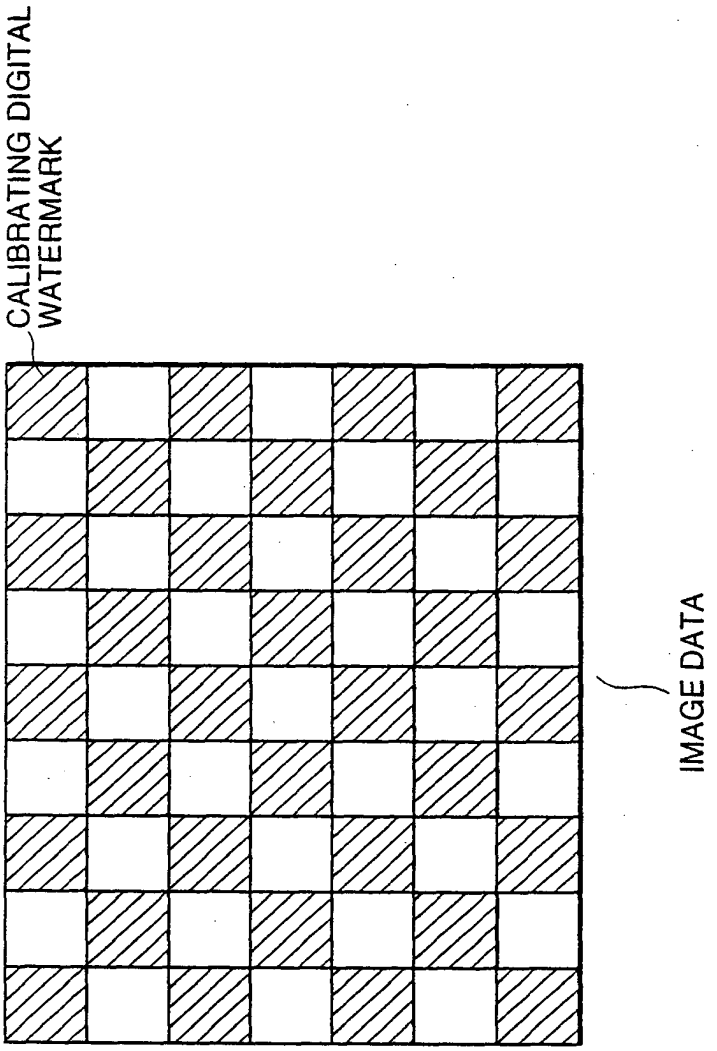


FIG. 20

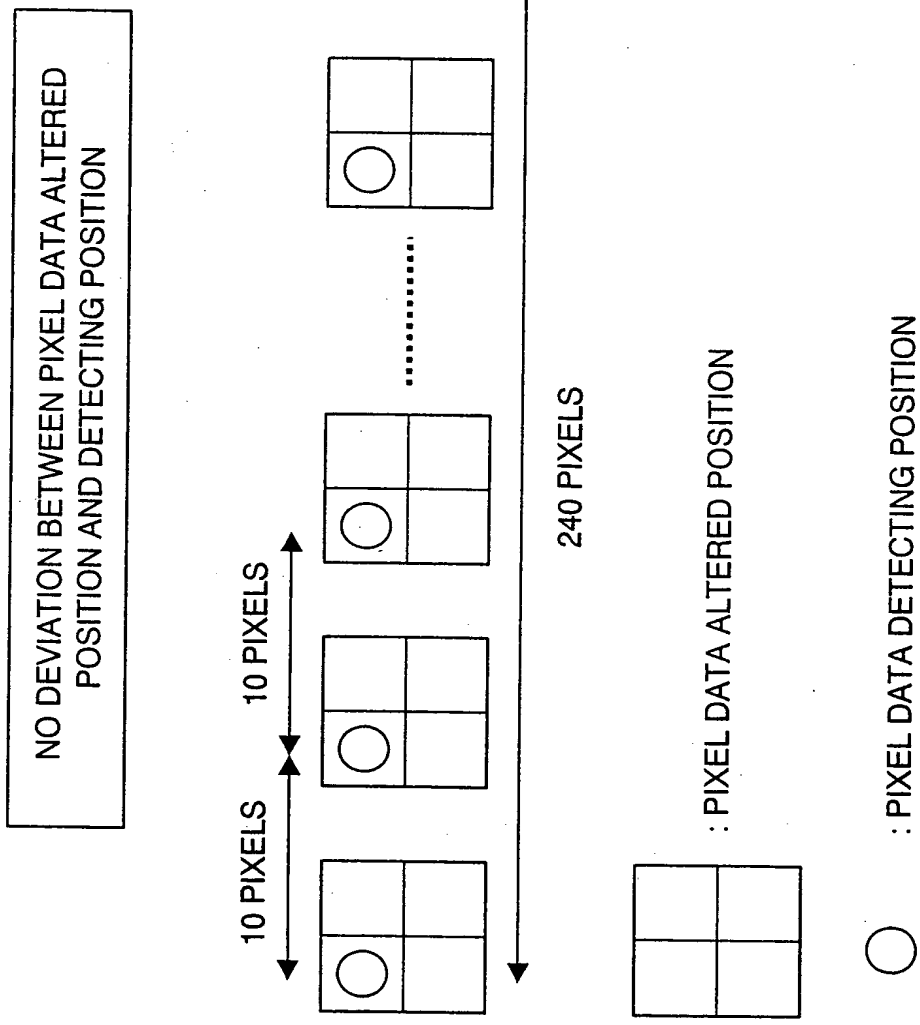
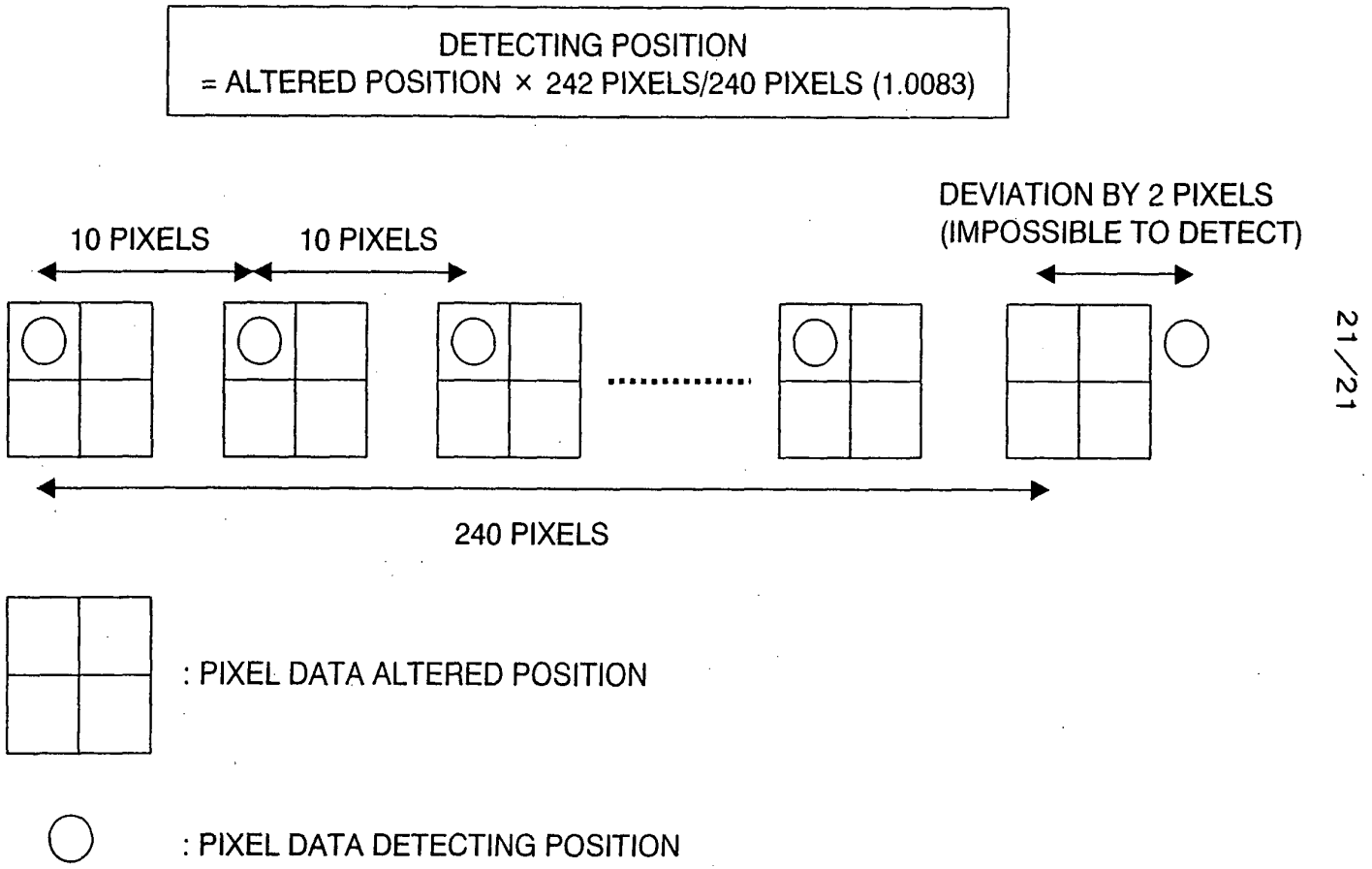

NO DEVIATION BETWEEN PIXEL DATA ALTERED POSITION AND DETECTING POSITION
10 PIXELS
10 PIXELS
240 PIXELS
: PIXEL DATA ALTERED POSITION
: PIXEL DATA DETECTING POSITION

FIG. 21


DETECTING POSITION
= ALTERED POSITION × 242 PIXELS/240 PIXELS (1.0083)
DEVIATION BY 2 PIXELS
(IMPOSSIBLE TO DETECT)
10 PIXELS
10 PIXELS
240 PIXELS
: PIXEL DATA ALTERED POSITION
: PIXEL DATA DETECTING POSITION